186/313

PATENT SPECIFICATION

(11) 1275827

DRAWINGS ATTACHED

(21) Application No. 46650/69 (22) Filed 22 Sept. 1969

(61) Patent of Addition to No. 1239767 dated 2 May 1968

(45) Complete Specification published 24 May 1972

(51) International Classification F16F 15/22 B21B 21/00

(52) Index at acceptance

F2X 1
B3M 10X 12B7 19D 27C 7X 9C 9N
F2S 8M1C 8M4G 8M5

(72) Inventors SERGEI NIKOLAEVICH KOZHEVNIKOV
ARKADY SEMENOVICH TKACHENKO
BRONISLAV MECHESLAVOVICH KLIMKOVSKY
JURY IVANOVICH CHEREVIK
EDUARD FEDOROVICH FEDOROVSKY and
ANATOLY VLADIMIROVICH PRAZDNIKOV

(54) DEVICE FOR BALANCING FORCES OF INERTIA IN RECIPROCALLY MOVING STANDS OF COLD ROLLING MILLS

(71) We, INSTITUT CHERNOI METALLURGII, of ulitsa Pisarzhevskogo 5, Dnepropetrovsk, Union of Soviet Socialist Republics, a corporation organized and existing under the laws of the Union of Soviet Socialist Republics, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an improvement of the apparatus to balance out forces of inertia in reciprocating masses, claimed in our Patent Application No. 5536/68 (Serial No. 1,239,767).

Claim 1 of Patent Application No. 5536/68 (Serial No. 1,239,767) claims an apparatus for balancing the inertia forces of reciprocating masses, such as work-performing stands of mills for cold rolling of pipes, comprising at least one fixedly mounted pneumatic cylinder assembly including a stationary part and a movable piston means, said movable piston means of said cylinder assembly being operatively connectable with the reciprocating masses to be balanced, said cylinder assembly being connected through a supply line to a source of air under pressure, wherein the said cylinder assembly is connected to said source of air under pressure through a pressure reducing valve adapted to maintain automatically a specified initial air pressure inside said cylinder assembly, said initial air pressure being independent of the pressure variations in said supply source and wherein a communication line is connected to said cylinder assembly on the opposite sides of the piston means of said cylinder assembly, said communication line having mounted therein a control valve adapted to maintain air communication between working spaces on opposite sides of the piston means during an initial stage of the motion of said masses and to discontinue such communication after said motion has reached a pre-set reciprocating condition.

The apparatus made according to the above-mentioned Patent Application, though it practically secures the complete balancing of the inertial forces of the stand mass (up to 90—95% thereof), does not balance out the inertial forces of the stand mass during the starting of the mill.

The object of the present invention is to further improve the invention previously claimed, and to provide a device which would be simple in construction, durable, and reliable in operation.

According to this invention there is provided an improvement in or modification of the apparatus for balancing the inertia forces of reciprocating masses as claimed in claim 1 of our patent application No. 5536/68 (Serial No. 1,239,767), wherein the apparatus is in the form of a rolling mill and the piston means is provided with a rod which is hollow and the longitudinal axis of the rod is in alignment with the nip of the rolls of the said mill.

Since the employment of a hollow piston rod reduces the volume of the working pressure spaces in the air cylinder, it is advisable to connect each working pressure space of the air cylinder with one of two additional closed spaces formed by a cylindrical chamber, and to provide this chamber with a displaceable lateral partition to regulate the

relative volume of the additional pressure spaces.

It is also advisable to provide the present device with two maximum pressure valves, each of which is connected with the respective working space of the air cylinder, the working spaces of said valves being permanently connected with one another by way of a communication main, while each of the high-pressure spaces of said valves is connected with said main by means of a piping which has a non-return valve, thus permitting automatic adjustment of the balancing device for a preset duty of the mill operation.

A non-return valve should preferably be used in the supply main of this device between the pressure reducing valve and the working spaces of the air cylinder in order to eliminate air pressure variations in the low pressure space of said reducing valve and raise the sensitivity of the latter to leakages.

Employment of the present invention resulting in a simplified construction of the balancing device and automatic adjustment thereof for the given work duty increases the number of the stand double strokes per unit time and reduces idle time, thus raising the production capacity of cold rolling pipe mills by as much as 35—40%.

The invention is further exemplified with an embodiment thereof and accompanying drawings.

The nature of the present invention will be made more fully apparent from a consideration of the following description thereof, taken in conjunction with the accompanying drawings, in which:—

Fig. 1 is a general view of the balancing device, shown as a partial sectional view, complete with the air-supply diagram, and

Fig. 2 illustrates the balancing device in a sectional view, provided with a system of regulating valves.

The balancing device (Fig. 1) comprises a double-acting air cylinder 1 whose centre line coincides with that of the rolling mill. Moving in the air cylinder 1 is a piston 2 which is rigidly fixed, by means of a sleeve 4 and a nut 5, to a hollow piston rod 3 (inside which the rolled pipe passes) having a longitudinal axis which is in alignment with the nip of rollers of the mill. Hollow rod 3 by way of cross-beam 6 is, in turn, rigidly jointed to roll stand 7 of the rolling mill. The end faces of air cylinder 1 are closed with covers 8 and 9, each of which has a sealing arrangement 10, adjustable cup packing 11, and guide bronze sleeve 12. Seal 10 consists of four to five cages, each of which has two cast-iron packing split rings.

Air cylinder 1 has headers 13 and 14 which are rigidly connected to similar headers of a cylindrical chamber 15 serving to increase the volume of the working pressure spaces of air cylinder 1. The sectional area of these headers is equal to, or little more than, the sectional area of the piston, so that additional consumption of power to let the air through these sections is excluded. The end faces of chamber 15 are closed with blind covers 16 and 17, and the inside space of this chamber is subdivided by a lateral partition 18 into two additional pressure spaces, each of which is connected to the respective pressure space of air cylinder 1. Constructionally the cylindrical chamber 15 is made so that the lateral partition 18 can change both its positions along the chamber's centre line (which permits regulating the relative volume of the additional pressure spaces), and its geometrical dimensions in width (i.e. be wider or narrower), which allows raising or reducing the general compression ratio in each pressure space independently.

Such a design enables a versatile balancing device to be made with minimum linear dimensions in length and with a compression ratio that can be varied within a wide range.

Air cylinder 1 of the balancing device is in its middle part hinged in two carrier bearings (not shown in Fig. 1), and can turn about a horizontal axis perpendicular to the centre line of the rolling mill. Thus, in case the supporting guides of stand 7 and of the bed are worn, as well as in the case of some inaccuracy in the position of both cylinder 1 or stand 7, these errors are corrected by a free turn of air cylinder 1 about said horizontal axis.

Compressed air is fed to the working spaces of air cylinder 1 and from an air supply source through valve 19, coarse filter 20 with a moisture separator, fine filter 21, pressure reducing valve 22, piping 23, and a non-return valve 24. The pressure of the non-return valve 24 in main 23 which connects the low pressure space of regulator 22 to the working spaces of air cylinder 1, permits eliminating air pressure variations in the low pressure space of reducing valve 22, and this provides for raising the sensitivity of the latter to leakages thus improving the reliability and operating capacity of the air supply system as a whole.

Connection of the coarse filter 20 in series with the fine filter 21 ensures compressed air cleaning of mechanical impurities and moisture up to 98—99%, thus completely ruling out clogging of the needle and non-return valves in the lubrication system, as well as of the initial pressure regulator 12 and considerably reducing wear of frictioning surfaces in the balancing device.

The pressure reducing valve 22 (Fig. 1 shows one of the possible constructions thereof) comprises housing 25, two pistons 26 and 27 of different diameters, valve 28, adjustment spring 29, spring washer 30, and adjustment screw 31. The regulator has a high pressure space A connected to a source of com-

pressed air, and a low pressure space B alternately connected with the working spaces of air cylinder 1. Reliable separation of spaces A and B in non-load position is ensured by spring 32. This regulator establishes in the working spaces of air cylinder 1 a required initial pressure of the air fed from the supply source, so as to completely balance out the inertial forces of the mass of stand 7, said initial pressure being maintained by regulator 22 automatically, irrespective of the air pressure in the supply source. Additional charging of the working spaces of air cylinder 1 with compressed air is realized by the same regulator alternately at minimum pressure in these spaces, i.e. at the moments where the roll stand 7 is passing through its extreme positions.

The valve 22 may be of any type and design, but it should automatically keep in the working spaces of air cylinder 1 the initial air pressure required to balance forces of inertia irrespective of the air pressure in the supply source, and should effect the additional air supply to the working spaces of air cylinder 1 at minimum pressure values. The adjacent pressure spaces of air cylinder 1 (Fig. 2) are connected with each other by piping 33 which is provided with a by-pass valve 34.

Moreover, the balancing device is provided with two maximum pressure valves 35 whose working pressure spaces C are permanently connected with each other through main 36, while each of the high pressure spaces D is connected with main 36 through pipings 37 wherein non-return valves 38 are provided.

Fig. 2 illustrates a preferred construction of by-pass valve 34 and maximum pressure valve 35. By-pass valve 34 consists of housing 39, plunger 40, working spring 41, adjustment cup 42, and an electromagnetic coil 43. Plunger 40 has at its bottom a shank 44 serving as a core of an electric magnet, and at its top there is provided stem 45 with spring washer 46 to accommodate working spring 41.

The maximum pressure valve 35 (Fig. 2) comprises housing 47, disc valve 48, piston 49, spring 50, spring washer 51, and adjustment screw 52.

Only one version of the designs of by-pass valve 34 and of maximum pressure valve 35 has been described here. Other design versions of these valves may be used in practice as well.

In a steady rolling process, the by-pass valve 34 is in a working position, main 33 which connects the working spaces of air cylinder 1 being shut by plunger 40, piston 2 moving in air cylinder 1 from one extreme position to the other at a certain rate, and the air expanding in one working space and being compressed in the other space. The resulting force of elastic resistance balances the inertial force of the mass of stand 7, thus neutralizing the effect of the inertial force on the drive elements of stand 7.

When stopping the mill, communication main 33 should be opened with some time lag, since the elastic resistance force of the air compressed in cylinder 1 is expedient to be used as a braking force at this stage of the piston movement. Thereafter, after the motor is cut off an electric current is fed to the coil of electric magnet 43 only with a certain time delay. The electric magnet operates, and plunger 40 of by-pass valve 34 takes the intial position at which communication main 33 opens, the working spaces of air cylinder 1 are connected with each other, and the air pressure therein is equalized.

At the moment of starting the mill, communication main 33 is not shut, so that the air in cylinder 1 is forced therealong from one working space to the other. The resulting limited force caused by the resistance to air movement through piping 33 balances, for the most part, the inertial forces of the mass of stand 7, being produced during the transient period of the mill operation.

After a certain time interval, when stand 7 has been accelerated and the forces of inertia have reached a definite permanent value characteristic for the steady mill operation, a time relay enters into operation so as to cut off the coil of electric magnet 43 and separates the working spaces of air cylinder 1 from each other. The numerical value of this time lag is experimentally determined according to the rate of the mill starting, and should be within the range of 3—6 seconds. The time relay is tuned to this value, and it must cut off the electro-magnetic coil at the moment when stand 7 cross the mid-point.

The latter requirement is caused by the fact that when stand 7 passes the midpoint the working spaces of air cylinder 1 contain approximately equal amounts of air, thus closure of communication main 33 at this moment providing for the subsequent conformity between the forces of inertia produced by the mass of stand 7 and the balancing force, in a preset steady rolling process.

However, energizing the time relay at the moment of stand 7 crossing the midpoint proved to be a rather hard problem in production conditions, requiring a special complicated and costly system of automatic control.

What would happen with the balancing force if the working spaces of air cylinder 1 are separated at an arbitrary position of piston 2. For this purpose, let us consider one of the most unfavourable cases, i.e. the moment where stand 7 is passing through the extreme right position.

In this case, the amount of air present in the left-hand pressure space of air cylinder 1 is several times that in the right-hand pressure space, and the air pressure there largely ex-

ceeds the required initial value. At the same time the air pressure in the right working space is far below that required in this case for a steady rolling process. Thus, the further movement of piston 2 in air cylinder 1 shall prove that at the extreme left position of the piston air pressure in the left working space will be much above the value that ought to be there in a steady rolling process, while in the right working space it will be several times lower than the required initial pressure.

This causes the value of the resultant balancing force affecting stand 7 in said position to be several times that of the inertial force acting on the elements of the stand driving mechanism in the same position when in a steady process. Hence, it turns out that at one stage of the movement of stand 7 (in this case, during the left stroke) the balancing force is of excessive value; while at the other stage (right stroke), it is insufficient, which involves the significant overloading of the drive elements of stand 7, as well as of the electric motor.

To eliminate the above disadvantage the present device is fitted with two maximum pressure valves 35, each of which is connected with the respective working space of air cylinder 1, the working pressure spaces of said valves being permanently connected with one another through a communication main 36, and each of the high pressure spaces of these valves being connected with said main by pipings 37 which include non-return valves 38.

In a steady rolling process, each of maximum pressure valves 35 is adjusted so as to satisfy condition

$$C \cdot X = P_m \cdot S \qquad (1)$$

where C and X are rigidity and deformation of spring 50, respectively;

P_m—maximum specific air pressure in the working spaces for a given steady rolling process;

S—the effective area of disk valve 48.

In this case, mains 36 and 37 do not communicate with the working spaces of air cylinder 1.

If main 33 is shut off when piston 2 is in its extreme right-hand position, and the piston continues moving from right to left, then somewhere after the midpoint air pressure will reach value P_m at which equality (1) is valid.

Further movement of piston 2 disturbs this equality, maximum pressure value 35 opens, and the excess air from the left working space of air cylinder 1 is forced through pipings 36 and 37, via non-return valve 38, to the right working space. Thus, air pressure in the left working space of air cylinder 1 does not exceed a definite preset value, while air pressure in the right working space by the end of the cycle becomes equal to the required initial value, i.e. the balancing device is automatically adjusted to the preset work duty.

Similar self-adjustment takes place when piston 2 moves from its extreme left position to the right one, as well as from any intermediate position.

Thus, employment of the described balancing device in cold rolling pipe mills permits establishing complete conformity between the inertial forces of the stand mass, and the elastic resistance forces developed in the working spaces of the air cylinder, both in a transient, and steady rolling processes, as well as realizing automatic adjustment of the balancing device to a preset duty of operation, i.e. making the mill starting process easier and faster.

The present invention is not limited by the description of its exemplary embodiment as set forth above, and it may be varied within the scope as defined by the accompanying claims.

WHAT WE CLAIM IS:—

1. An improvement in or modification of the apparatus for balancing the inertia forces of reciprocating masses as claimed in claim 1 of our patent specification No. 5536/68 (Serial No. 1,239,767), wherein the apparatus is in the form of a rolling mill and the piston means is provided with a rod which is hollow and the longitudinal axis of the rod is in alignment with the nip of the rolls of the said mill.

2. Apparatus as claimed in claim 1, wherein each working space of the pneumatic cylinder assembly communicates with one of two closed spaces additionally formed in the apparatus.

3. Apparatus as claimed in claim 2, wherein said additional spaces are formed by means of a cylindrical chamber whose inner space is divided with a displaceable cross partition to regulate the relative volume of the additional pressure spaces.

4. Apparatus as claimed in any one of claims 1 to 3, comprising two maximum pressure valves, each of which is connected with a respective working space of the air cylinder, the low pressure spaces of said valves being permanently connected with each other through a communication main, and each of the high pressure spaces of these valves being connected with said main through pipings which include non-return valves.

5. An apparatus as claimed in any one of claims 1 to 4, wherein a non-return valve is placed in a supply main between the pressure reducing valve and the working spaces of the pneumatic cylinder assembly in order to eliminate air pressure variations in the low pressure space of said reducing valve, and raise the sensitivity of the latter to leakages.

6. Apparatus for balancing the inertia forces of reciprocating masses substantially as described above and illustrated in the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Agents for the Applicant(s).

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1972.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1275827 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

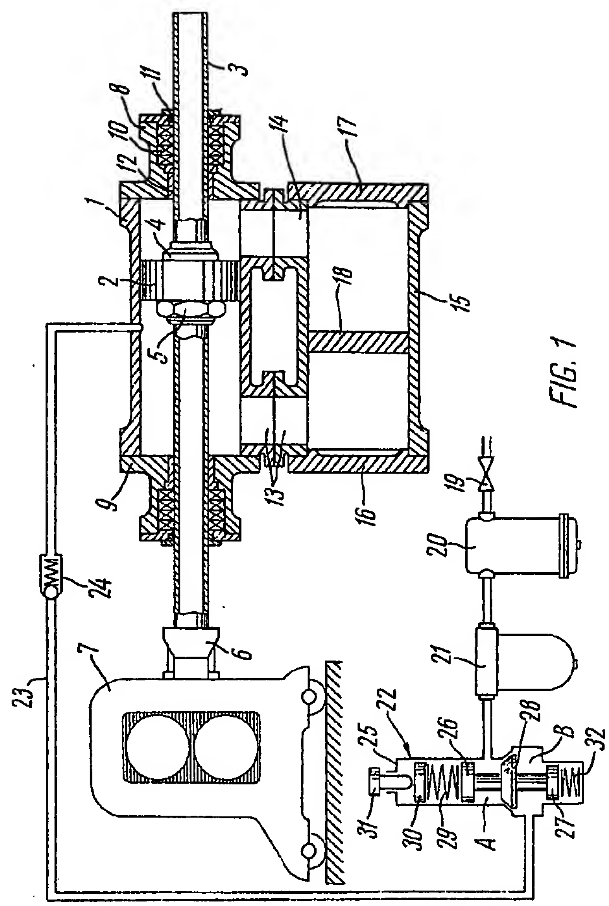

FIG. 1

1275827 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

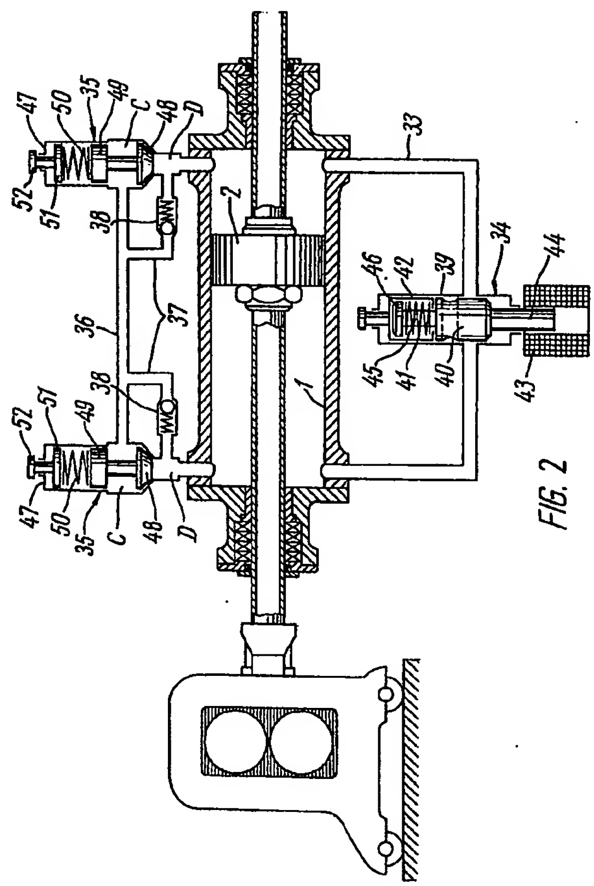

FIG. 2